LXIII. *An Account of a printed Memoir, in* Latin, *presented to the Royal Society, intituled,* De Veneris ac Solis congreſſu obſervatio, habita in aſtronomicâ ſpeculâ Bononienſis Scientiarum Inſtituti, die 5 Junii 1761. Auctore Euſtachio Zanotto, ejuſdem Inſtituti Aſtronomo, ac Regiæ utriuſque Londinenſis et Berolinenſis Academiæ Socio. *By* Nathanael Bliſs, Savilian *Profeſſor of Geometry, and F. R. S.*

Read July 1, 1762.

THE planet Venus hath been ſo ſeldom obſerved in thoſe circumſtances, which are of the greateſt uſe in determining ſome of the moſt eſſential elements of its motion, that every ſuch obſervation, made by an accurate aſtronomer, cannot but be very acceptable to the public.

At Bologna, on the night preceding the day of the tranſit, the weather was very unfavourable; but early in the morning, the clouds, which covered the whole hemiſphere, began to break, and were driven off towards the horizon, by a gentle wind: ſo that the obſervations were retarded only during the ſpace of about half an hour. Father Friſi, profeſſor of mathematics at Piſa, and Signors Mathenci and Marini, aſſiſted in making the obſervations; the two latter obſerving, in the upper room of the obſervatory, together with Mr. Profeſſor Zanotti; and Father Friſi, accompanied by the two profeſſors of mathematics Signors Caſali and Canterzani, in a lower chamber.

S. Zanotti, in order to determine the place of Venus on the Sun, made uſe of a quadrant of $2\frac{1}{2}$ feet radius, in the teleſcope of which were placed two wires, the one in an horizontal, the other in a vertical direction: by obſerving the appulſes of the limbs of the Sun and Venus to theſe wires, ſucceſſively, no error from refraction can take place. But it is of no ſmall conſequence to the accuracy of theſe obſervations, that the wires ſhould be placed truly perpendicular to each other. For this purpoſe, the quadrant was placed in the plane of the meridian, and a ſtar, during its tranſit, was obſerved more than once, accurately to run along the horizontal wire. Though the poſition of the vertical wire was often tried by terreſtrial objects, yet other methods of examination were made uſe of. At the ſame altitude, both before and after noon, the paſſage of the Sun not only over the horizontal, but alſo over the vertical wire, was obſerved, that it might from thence appear, whether the times of paſſage, when the neceſſary errors in obſerving are allowed for, were equal in both caſes. In each of the following obſervations, the altitude is not nicely determined; becauſe an error of one degree would occaſion little or no difference in the quantity of the parallax.

The obſervations, fourteen in number, as given by the author, follow:

Obſervation 1ſt. Altitude 5° 14′.

H	′	″	
16	54	37	☉'s preceding limb at the horizontal wire.
	54	45½	☉'s preceding limb at the vertical wire.
	56	15	♀'s preceding limb at the vertical wire.

H

H	′	″	
16	56	20	♀'s consequent limb at the vertical wire.
	57	20	♀'s preceding limb at the horizontal wire.
	57	26	♀'s consequent limb at the horizontal wire.
	57	54	☉'s consequent limb at the horizontal wire.
16	57	55	☉'s consequent limb at the vertical wire.

Observation 2d. Altitude 7° 0′.

H	′	″	
17	5	56½	☉'s preceding limb at the horizontal wire.
	5	59½	☉'s preceding limb at the vertical wire.
	7	25½	♀'s preceding limb at the vertical wire.
	7	30½	♀'s consequent limb at the vertical wire.
	8	35½	♀'s preceding limb at the horizontal wire.
	8	40½	♀'s consequent limb at the horizontal wire.
	9	11½	☉'s consequent limb at the horizontal wire.
17	9	13	☉'s consequent limb at the vertical wire.

Observation 3d. Altitude 8° 10′.

H	′	″	
17	12	50½	☉'s preceding limb at the horizontal wire.
	12	53	☉'s preceding limb at the vertical wire.
	14	16	♀'s limb at the vertical wire.
	14	22	♀'s consequent limb at the vertical wire.
	15	27	♀'s preceding limb at the horizontal wire.
	15	32	♀'s consequent limb at the horizontal wire.
	16	4	☉'s consequent limb at the horizontal wire.
17	16	7	☉'s consequent limb at the vertical wire.

Observation 4th. Altitude 9° 8′.

H	′	″	
17	19	24	☉'s preceding limb at the horizontal wire.
	19	29	☉'s preceding limb at the vertical wire.

H	′	″	
17	20	50	♀'s preceding limb at the vertical wire.
	20	55½	♀'s conſequent limb at the vertical wire.
	21	57½	♀'s preceding limb at the horizontal wire.
	22	3	♀'s conſequent limb at the horizontal wire.
	22	35	☉'s conſequent limb at the horizontal wire.
17	22	45½	☉'s conſequent limb at the vertical wire.

Obſervation 5th. Altitude 10° 50′.

H	′	″	
17	29	41	☉'s preceding limb at the horizontal wire.
	29	55½	☉'s preceding limb at the vertical wire.
	31	14½	♀'s preceding limb at the vertical wire.
	31	20	♀'s conſequent limb at the vertical wire.
	32	10	♀'s preceding limb at the horizontal wire.
	32	16	♀'s conſequent limb at the horizontal wire.
	32	50½	☉'s conſequent limb at the horizontal wire.
17	33	15½	☉'s conſequent limb at the vertical wire.

Obſervation 6th. Altitude 14° 12′.

H	′	″	
17	49	38½	☉'s preceding limb at the horizontal wire.
	49	42½	☉'s preceding limb at the vertical wire.
	50	55	♀'s preceding limb at the vertical wire.
	51	1½	♀'s conſequent limb at the vertical wire.
	51	58½	♀'s preceding limb at the horizontal wire.
	52	4½	♀'s conſequent limb at the horizontal wire.
	52	42½	☉'s conſequent limb at the horizontal wire.
17	53	7½	☉'s conſequent limb at the vertical wire.

Obſervation

Obſervation 7th. Altitude 17° 0′.

H	′	″	
18	6	3½	⊙'s preceding limb at the horizontal wire.
	6	15	⊙'s preceding limb at the vertical wire.
	7	11	♀'s preceding limb at the vertical wire.
	7	17	♀'s conſequent limb at the vertical wire.
	8	31	♀'s preceding limb at the horizontal wire.
	8	36½	♀'s conſequent limb at the horizontal wire.
	9	18	⊙'s conſequent limb at the horizontal wire.
18	9	31½	⊙'s conſequent limb at the vertical wire.

Obſervation 8th. Altitude 23° 40′.

H	′	″	
18	44	36½	⊙'s preceding limb at the horizontal wire.
	45	15½	⊙'s preceding limb at the vertical wire.
	46	7½	♀'s preceding limb at the vertical wire.
	46	14	♀'s conſequent limb at the vertical wire.
	46	39½	♀'s preceding limb at the horizontal wire.
	46	47	♀'s conſequent limb at the horizontal wire.
	47	36	⊙'s conſequent limb at the horizontal wire.
18	48	49	⊙'s conſequent limb at the vertical wire.

Obſervation 9th. Altitude 31° 42′.

H	′	″	
19	30	15	⊙'s preceding limb at the horizontal wire.
	30	22	⊙'s preceding limb at the vertical wire.
	30	59	♀'s preceding limb at the vertical wire.
	31	5	♀'s conſequent limb at the vertical wire.
	32	6	♀'s preceding limb at the horizontal wire.
	32	11	♀'s conſequent limb at the horizontal wire.
	33	11½	⊙'s conſequent limb at the horizontal wire.
19	34	0	⊙'s conſequent limb at the vertical wire.

Obſervation 10th. Altitude 34° 15′.

H	′	″	
19	44	10½	☉'s preceding limb at the horizontal wire.
	44	26½	☉'s preceding limb at the vertical wire.
	44	58½	♀'s preceding limb at the vertical wire.
	45	5½	♀'s conſequent limb at the vertical wire.
	45	59	♀'s preceding limb at the horizontal wire.
	46	4½	♀'s conſequent limb at the horizontal wire.
	47	7½	☉'s conſequent limb at the horizontal wire.
19	48	4	☉'s conſequent limb at the vertical wire.

Obſervation 11th. Altitude 37° 21′.

H	′	″	
20	2	1½	☉'s preceding limb at the horizontal wire.
	2	14	☉'s conſequent limb at the vertical wire.
	2	38	♀'s preceding limb at the vertical wire.
	2	44	♀'s conſequent limb at the vertical wire.
	3	46½	♀'s preceding limb at the horizontal wire.
	3	52	♀'s conſequent limb at the horizontal wire.
	4	59½	☉'s conſequent limb at the horizontal wire.
20	5	49	☉'s conſequent limb at the vertical wire.

Obſervation 12th. Altitude 41° 7′.

H	′	″	
20	23	0½	☉'s preceding limb at the horizontal wire.
	23	1½	☉'s preceding limb at the vertical wire.
	23	18	♀'s preceding limb at the vertical wire.
	23	24½	♀'s conſequent limb at the vertical wire.
	24	41½	♀'s preceding limb at the horizontal wire.
	24	48	♀'s conſequent limb at the horizontal wire.
	26	0	☉'s conſequent limb at the horizontal wire.
20	26	36	☉'s conſequent limb at the vertical wire.

Obſervation

Obſervation 13th. Altitude 44° 10′.

H	′	″	
20	40	16	☉'s preceding limb at the horizontal wire.
	40	22	☉'s preceding limb at the vertical wire.
	40	33½	♀'s preceding limb at the vertical wire.
	40	39	♀'s conſequent limb at the vertical wire.
	41	56½	♀'s preceding limb at the horizontal wire.
	42	1½	♀'s conſequent limb at the horizontal wire.
	43	17½	☉'s conſequent limb at the horizontal wire.
20	43	53½	☉'s conſequent limb at the vertical wire.

Obſervation 14th. Altitude 46° 28′.

H	′	″	
20	53	51½	☉'s preceding limb at the horizontal wire.
	53	58½	☉'s conſequent limb at the vertical wire.
	54	3½	♀'s preceding limb at the vertical wire.
	54	9	♀'s conſequent limb at the vertical wire.
	55	30	♀'s preceding limb at the horizontal wire.
	55	36	♀'s conſequent limb at the horizontal wire.
	56	54	☉'s conſequent limb at the horizontal wire.
20	57	25½	☉'s conſequent limb at the vertical wire.

When the planet drew near to the edge of the Sun's diſk, the obſervers prepared to determine the time of the two contacts, Profeſſor Zanotti, with the teleſcope of the quadrant of 2½ feet focus, Profeſſor Mathenci, with the teleſcope of 22 feet, and Signor Marini, with that of 10 feet.

The

The internal contact was obſerved

	H	′	″		
At	21	4	34	with the teleſcope of	$2\frac{1}{2}$ feet.
	21	4	58	- - - - - - -	10 feet.
	21	4	58	- - - - - - -	22 feet.

The external contact was obſerved

	H	′	″		
At	21	22	30	with the teleſcope of	$2\frac{1}{2}$ feet.
	21	23	0	- - - - - - -	10 feet.
	21	23	7	- - - - - - -	22 feet.

During the intervals of the obſervations made with the quadrant, the planet was always obſerved to be perfectly round, without any ring or nebuloſity.

It may, at firſt ſight, ſeem wonderful, ſays Signor Zanotti, that obſervations made with different teleſcopes, one of 10, the other of 22 feet, ſhould ſo nearly coincide, the times of the firſt contact agreeing to the ſame ſecond, and thoſe of the laſt differing only 7 ſeconds, by which the contact was ſeen to happen ſo much later through the longer teleſcope; and the blame might be laid either upon the longer teleſcope, or upon the obſerver. The goodneſs of the teleſcope will readily be allowed, when it is known, that it was made by Campani; and the ſkill and dexterity of the obſerver are too well known, to give room for any ſuſpicion on his part. It may rather be attributed to the near equality of the magnifying power of the two inſtruments; the longer teleſcope having an eye-glaſs of 3 inches focal length, and the ſhorter an eye-glaſs of $1\frac{1}{4}$; by means of which,

which, the images of the Sun and Venus were nearly equal in both.

The author then proceeds to determine, by calculation, (the method of which he has at large explained) the difference of longitude between the centers of the Sun and Venus; and alſo the planets latitude, which, as ſeen from the Earth's center, are, at the time of each obſervation, as in the following table.

N. B. The author has not mentioned the exact quantity of the Sun's parallax, which he made uſe of in theſe computations: but, from ſome trials, it ſhould ſeem, that he ſuppoſed the parallax of the Sun to be $10\frac{1}{2}$ or 11 ſeconds.

True time, after the noon.	Difference of longitude between ☉ and ♀.	Latitude ♀ South.
H ′ ″	′ ″	′ ″
16 56 17½	5 46 East.	8 31
17 7 28	5 7 East.	8 40½
17 14 19	4 41½ East.	8 46
17 20 52¾	4 15½ East.	8 56
17 31 17¼	3 36½ East.	8 54
17 50 58¼	2 18 East.	9 0
18 7 14	1 21½ East.	9 14
18 46 10¾	1 19 West.	9 46
19 31 12	4 19½ West.	10 4
19 45 2	5 1½ West.	10 13
20 2 41	6 20½ West.	10 28½
20 23 21	7 46½ West.	10 41
20 40 36¼	8 46 West.	10 49
20 54 6¼	9 46 West.	11 0

These longitudes and latitudes do not exactly answer to the interval of time between each observation: but the observer has related them faithfully as they were taken; and if we consider, that they were determined by time, and that an error of half a second will have a considerable influence upon each observation, it will readily be allowed, that the observations are carefully made, and agree very well together, though

though taken with an inſtrument of ſo ſmall a radius. The following are the elements deduced from thoſe obſervations, which were made at the diſtance of at leaſt an hour and an half:

	°	'	''
The horary motion of ♀ in longitude -	0	3	$55\frac{4}{5}$
The horary motion in latitude - - -	0	0	$36\frac{3}{5}$
	H	'	''
The true time of the conjunction of ☉ and ♀ - - - - - - - - -	18	26	0
	°	'	''
The latitude of ♀ at the conjunction -	0	9	$27\frac{5}{6}$

From theſe numbers the author deduced the following elements, by trigonometrical calculation:

	°	'	''
The angle of the path with the ecliptic	8	49	23
The horary motion in the path - -	0	3	$58\frac{2}{3}$
The part of the path between the middle of the tranſit and the conjunction -	0	1	27
The diſtance of the path from ☉'s center ſouthwards - - - - - - - -	0	9	21
The length of the path within the ☉'s diſk - - - - - - - - - -	0	25	$29\frac{1}{2}$
The difference of longitude of ☉ and ♀ at the ingreſs - - - - - - -	0	14	2
The difference of longitude at the egreſs	0	11	$9\frac{1}{2}$
The latitude of ♀ at the ingreſs ſouth -	0	7	17
The latitude of ♀ at the egreſs ſouth -	0	11	12
	H	'	''
The time of the middle of the tranſit -	18	4	6
The ingreſs of the center of ♀ on the ☉'s diſk - - - - - - - - - -	14	51	49
The egreſs of the center of ♀ - - - -	21	16	23

It appears alſo by his calculation, that the time of the internal contact was accelerated 30″, and the laſt contact 18″, by parallax. The internal contact, therefore, as ſeen from the center of the Earth, was at $21^h\ 5'\ 28''$, and the external contact was at $21^h\ 23'\ 25''$, and the egreſs of the planet's center at $21^h\ 14'\ 33''$.

From the time of the planet's paſſage over the edge of the Sun's diſk, as ſeen from the Earth's center, the author very accurately determines the planet's diameter to be $57''\frac{2}{3}$.

The egreſs of the center of Venus, as deduced from the poſition of its path, and from the other elements, as related above, differs near two minutes from the obſerved time, when corrected by parallax, and reduced to the Earth's center. This difference is entirely to be attributed to an error in the motion of Venus in longitude, which, perhaps, could not be deduced with ſufficient accuracy from theſe obſervations, and from a ſmall error in ſome of the other elements; all which the author might have taken, with the utmoſt accuracy, from the tables either of Dr. Halley or M. Caſſini. Perhaps alſo, ſome part of this difference might ariſe from our ignorance of the true quantity of the Sun's parallax.

Hitherto our author has given us thoſe elements, which might immediately be determined from his obſervations: the following are deduced from the tables. From the the motion of Venus in latitude, it may readily be collected, that the planet was in its node on June 5, at $14^h\ 55'\ 9''$. The place of the Sun at that time, according to the tables of the Abbé De la Caille, was in ♊ 14° 59′ $5''\frac{1}{2}$; and the planet's

planet's elongation from the Sun, at the ſame time, was 1° 0° 58″. Therefore, the longitude of Venus, and alſo of the node, was in ♊ 13° 58′ 7″$\frac{1}{2}$. The angle at the Sun, or the difference of the longitude of the planet and the Earth, as ſeen from the Sun, was 0° 24′ 15″. Therefore, the longitude of the deſcending node of Venus, as ſeen from the Sun, was in ♐ 14° 34′ 50″.

The latitude of Venus, as ſeen from the Earth, at the time of the conjunction, was 0° 9′ 27″$\frac{5}{6}$; by ſolving a triangle of which, the computed diſtances of the Earth and Venus from the Sun conſtitute two ſides, the angle at the Sun, or the planet's heliocentric latitude, viz. 0° 3′ 46″, will be determined. With this heliocentric latitude, and the calculated place of the Sun at the time of the conjunction, and the longitude of the node, as before laid down, from two ſides of a ſpheric right-angled triangle, an angle may be computed, which will expreſs the inclination of the planet's orbit with the ecliptic. The place of the Sun, at the time of the conjunction, was in ♊ 15° 36′ 10″. The difference of the heliocentric longitude of the earth, and the node, was 1° 1′ 20″. Therefore the angle of the inclination of the orbit of Venus with the ecliptic is 3° 30′ 49″.

N. B. The ſeveral numbers contained in this paper, are taken from the correct numbers written in the margin of the printed memoir, with the author's own hand, and which ſeem to be the reſult of his lateſt calculations. And though his obſervations were made with great care, and faithfully calculated, yet the reſults will not be found ſo accurate, as could

 be

be wiſhed; ſince the latitude of Venus, deduced from theſe obſervations, is, in all probability, 10″ or 12″ too little; a quantity, which muſt have a very ſenſible influence, both on the place of the node, and the inclination of the planet's orbit with the ecliptic; the latter of which ought to be deduced from obſervations made on the planet, when in its greateſt latitudes.

In the lower chamber of the obſervatory, the obſervers made uſe of two teleſcopes, one of 6, the other of 8 feet, furniſhed with wires at half-right angles, in order to determine the place of Venus on the Sun, by cauſing the Sun's ſouthern limb to run down one of the threads: the following obſervations were made:

Obſervation 1ſt.

H	′	″	
18	11	40½	Sun's center at the horary wire.
18	11	50	Venus's center at the horary wire.
		26	The difference between the horary and oblique wires.

Obſervation 2d.

H	′	″	
19	24	1½	Center of ♀ at horary wire.
19	24	17½	Center of ☉ at horary wire.
		23	Difference between the horary and oblique wires.

Obſervation 3d.

H	′	″	
20	16	53	Center of ♀ at horary wire.
20	17	23	Center of ☉ at horary wire.
		20	Difference between the horary and oblique wires.

Obſervation 4th.

H	′	″	
20	47	22½	Center of ♀ at horary wire.
20	47	55½	Center of ☉ at horary wire.
		17	Difference between the horary and oblique wires.

Obſervation 5th.

H	′	″	
20	59	17	Center of ♀ at horary wire.
20	59	54½	Center of ☉ at horary wire.
		15¾	Difference between the horary and oblique wires.

The internal contact was obſerved, by three different teleſcopes,

	H	′	″	
At	21	4	54	with a teleſcope of 6 feet.
	21	5	0	- - - - - - - 8 feet.
	21	4	56	- - - - - - - 11 feet.

The

The external contact was obſerved

	H	′	″		
At	21	22	53	with a teleſcope of	6 feet.
	21	22	50	- - - - - -	8 feet.
	21	22	59	- - - - - -	11 feet.

Profeſſor Canterzani examined the obſervations by projection, and found them to agree very nearly with thoſe made in the upper chamber by Signor Zanotti.

END of PART I.

ERRATUM.

Page 198, Line 11, for *from*, read *with*.

ERRATUM in VOL. LI. PART II.

Page 922, Line 2, for *ſum or difference*, read *difference or ſum*.